

INDUSTRIAL SOLVENT MANUAL FOR PESTICIDES FORMULATIONS



Ontario

Ministry of the
Environment

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PESTICIDES CONTROL SERVICE

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Environment Ontario

MINISTRY OF THE ENVIRONMENT
PESTICIDES CONTROL SERVICE

INDUSTRIAL SOLVENT MANUAL
FOR
PESTICIDES FORMULATIONS

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INDUSTRIAL SOLVENTS

INTRODUCTION

Industrial solvents have been used by man since probably soon after that day in our history when the first wheel turned on the first axle.

Man's knowledge grew over the centuries (particularly the last one) so too did his ability to invent and manufacture. Now he produces a vast quantity of machines and other equipment for his own use and to keep them running he has an equally vast quantity and variety of materials at his disposal. These products vary widely in physical properties and the applications for which they are designed or suited, but they all have at least that one property in common - they will dissolve other substances.

Of all the materials used, there's one that approaches the ideal in terms of desirable physical properties, safety, low cost, and the large number of other substances that it will dissolve. That, of course, is water.

Most people don't think of water in terms of being a solvent, but it's forever being used to perform solvent actions that are vital to our wellbeing and even to our survival. Water dissolves plant foods that are present in or added to the soil and carries this nourishment to the plant roots. In the form of rain, water washes dust from plant leaves so that they may breath.

But in industry, and particularly those industries that are engaged in pest control, solvents play a very important factor.

Solvents may contribute to the danger of insecticidal formulations either through their inherent toxicity or through their solubilizing action on the so-called active ingredients. In some instances, cases of poisoning by solutions of insecticides have been characterized by symptoms and clinical course indistinguishable from those caused by the solvent alone.

PETROLEUM SOLVENTS

Petroleum solvents are among the most widely used of the commercial solvents, and the more commonly used of these are naphta, kerosene, and mineral spirits.

Petroleum solvents are by-products from the refining of crude oil. They are relatively low in cost compared to other solvents. They have good solvent power for most of the soils encountered. In ordinary

industrial handling, where common sense and safe operating practices are exercised, their vapours, when inhaled into the lungs, are not likely to cause harm to vital body organs. However, in varying degrees, petroleum solvent vapours will form flammable and explosive mixtures in air. This, of course, limits their use in certain areas. Many of them leave a petroleum residue on drying and this could be an advantage or a disadvantage to the user, depending on his application.

KEROSENE

Identity: Kerosene, or coal oil, is a mixture of principally aliphatic hydrocarbons distilled from petroleum in the temperature range of 204° to 315°C. Other petroleum fractions such as diesel fuels Nos. 1 and 2 are closely related chemically, and much of this section pertains to such fractions also.

Formulations: Kerosene is one of the most common solvents in insecticidal solutions and emulsions, especially in sprays of the household type, which may contain up to 98% kerosene. This solvent is usually highly refined and—unlike fuel grade kerosene—essentially odorless. Other toxic solvents are often included in formulations of insecticides.

Uses: Kerosene is used as a solvent, diluent, and vehicle in sprays for household, agricultural, and public health use. Kerosene is also commonly used alone as an herbicide, as a fuel, as an industrial solvent, and for many other purposes.

Routes of Absorption: Kerosene may be absorbed orally or through the respiratory tract. Its dermal absorption is not significant for systemic poisoning under ordinary conditions of exposure.

Pharmacologic Action: Systemically, kerosene acts as a narcotic producing depression that may or may not be preceded by an excitement phase. At least in connection with ingestion, depression per se is apparently never fatal although it may be alarming. Liver and kidney damage may occur in severe cases. Coma and other major central nervous system effects are frequently present in cases that result from fumes and are serious enough to come to medical attention. However, such serious effects have been reported in only few cases involving ingestion. Ingestion of kerosene has been known to produce rapid death by gross aspiration and occlusion of the respiratory system. Even when death does not occur promptly, there is abundant evidence that the pneumonia commonly seen in children who swallow kerosene usually results from aspiration. The aspiration usually occurs at the moment of ingestion or as the result of vomiting within the first hour. Animal experiments prove that kerosene is absorbed from the gastrointestinal tract. Concentrations of aromatics as high as 140 ppm and of aliphatics as high as 917 ppm were found in blood or tissues. In spite of this absorption, the

lungs of animals receiving dosages of 13 ml/kg or less with precautions to prevent aspiration were normal histologically when the animals were sacrificed. The lungs of rats dosed at 18 ml/kg showed moderate changes on sacrifice, and rats killed by 30 to 40 ml/kg showed more marked pathology of the lungs as well as liver and kidney changes. Fatal aspiration leads to gross hemorrhagic pneumonitis most severe in the hilar and dependent portion of the lung in contrast to the even distribution of hemorrhage following rapid intravenous injection or pulmonary edema following slow intravenous injection. It would appear that, in the absence of aspiration, the dosage of kerosene necessary to produce pneumonitis or other serious effects is greater than that likely to be ingested. Evidence on the effect of mineral oil and vegetable oil on absorption of kerosene is conflicting.

Like many other oils, kerosene is a local irritant and may cause a maculopapular eruption of the exposed skin. The irritation tends to increase and later decrease with repeated exposure over a long period.

Dangerous Single Dose to Man: Although kerosene is a common cause of poisoning especially in children, the amount taken is seldom known. Survival has been reported following the ingestion of one liter, but death has followed the ingestion of doses as small as 30 ml., especially after kerosene was aspirated. The air concentration capable of producing acute symptoms by inhalation is not known. Chronic intoxication has not been reported.

Signs and Symptoms of Poisoning of Man: The use of kerosene sprays in closed or poorly ventilated spaces may lead to fullness of the head, headache, blurred vision, dizziness, unsteady gait, nausea. More massive exposure may cause collapse, nervous twitching, and coma before the victim is apparently aware of overexposure and before he seeks fresh air.

Ingestion frequently results in immediate gagging and coughing and thus leads to aspiration of the oil. The initial symptoms are followed by deep drowsiness. In the more serious cases, broncho pneumonia may develop in 24 to 36 hours. Chest signs are likely to be few or absent even when X-ray of the chest reveals an extensive bronchopneumonia. Liver and kidney damage may be manifested by hepatomegaly and by albumin, cells, and casts in the urine.

Treatment: The injury caused by inhalation of kerosene fumes seldom requires any treatment except prompt removal from exposure.

If kerosene containing no insecticide has been ingested, gastric lavage may be done mainly as a precaution against regurgitation and aspiration from the gastrointestinal tract. A recent study has shown that gastric lavage was not harmful to patients but there

was no conclusive evidence that it was beneficial. This is encouraging in connection with cases in which the ingested kerosene was the solvent for an insecticide that should be removed rapidly and thoroughly. If attempted, the gastric lavage should be done very early before narcosis sets in and every other possible precaution, including use of an intratracheal tube with inflated balloon, should be taken so that the lavage itself does not lead to aspiration of the kerosene. Emetics are contra indicated. Oil laxatives should be avoided, especially if the kerosene was the vehicle for an insecticide. A saline laxative may be helpful. Oxygen should be used promptly if the patient shows any respiratory difficulty or the slightest cyanosis.

Kerosene dermatitis requires no special treatment and will regress spontaneously if exposure is discontinued. Cleanliness will help to prevent its occurrence.

XYLENE

Chemical Name: A mixture of o-, m-, and p-xylene. (The ortho isomer is predominant in percentage.)

Formulations and Uses: Xylene is a common solvent in insecticidal solutions, emulsifiable concentrates, and emulsions. It is extensively used in industry especially as the main constituent of "solvent naphtha."

Routes of Absorption: Xylene is absorbed when taken orally or inhaled by the respiratory tract. Its dermal absorption is not significant under ordinary conditions of exposure.

Pharmacologic Action: Undiluted xylene is a severe irritant to mucous membranes and delicate skin. Xylene can cause a local dermatitis on any type of skin if used repeatedly. When absorbed, it acts as a narcotic and affects the circulating red blood cells.

Dangerous Single and Repeated Doses to Man: The smallest oral dose which may prove fatal is unknown. The threshold limit value for xylene in air has been set at 870 mg/M³.

Signs and Symptoms of Poisoning in Man: Local application to tender skin or to the eyes results in intense burning. Exposure to vapors in a poorly ventilated room results in headache, disturbed vision, dizziness, poor coordination, and nausea. Severe exposure may lead to collapse and coma. Repeated exposure may lead to moderate anemia as well as headache, dizziness, malaise, loss of appetite, ready fatigue and later nausea, chilliness, and hemorrhage from the nasal mucosae. It should be pointed out that commercial grades of xylene may be contaminated by appreciable amounts of benzene, so that the inhalation of the vapor may affect the hematopoietic system.

Treatment: If the eyes or skin are contaminated, they should be thoroughly washed. Two percent butyn sulfate ophthalmic ointment may be placed in the eyes immediately after washing to allay pain; later cortisone ophthalmic ointment may be used to reduce inflammation. Any analgesic ointment may be applied to the skin.

If xylene has been taken by mouth, an effort should be made to remove it by induced vomiting and by gastric lavage. Oil laxatives should be avoided if the xylene served as a vehicle for an insecticide. Saline laxatives may be used. General care of the patient is symptomatic.

FLAMMABILITY LIMITS

The flammability limits define the solvent temperature region in which the solvent will release the proper amount of hydrocarbon vapor to form a flammable mixture with air. It is assumed that the solvent has released the amount of vapor which would be in equilibrium with it at a given temperature. This equilibrium condition probably prevails in at least part of the vapor space under most conditions. It is important to note that temperature flammability limits refer to the temperature of the solvent in the immediate vicinity of the vapor space.

In estimating whether or not a flammable vapor space exists in a system, one must consider all the temperatures that may occur in the surrounding area. If any of the solvent temperatures lie within the flammability region for the solvent in question, it is reasonable to assume that at least part of the vapor space contains a flammable mixture.

FLASH POINT

Flash Point, which is closely related to the lower flammability limit, is the lowest solvent temperature at which a combustion flash can occur. It is measured by introducing a small test flame into the vapor space above a solvent in a standardized apparatus at one atmosphere of air pressure. The flash point is higher than the sea level lean flammability limit due to the method of measurement. On the other hand, flammability limits are determined experimentally by spark ignition of air vapor mixtures under temperature and pressure controlled conditions. At any given air pressure, the lower flammability limit is defined as the minimum hydrocarbon vapor concentration at which a spark ignited flame will traverse the vapor mixture.

In practice, it is common to measure the flash point rather than the lower flammability limit due to the relative ease and simplicity of measurement.

ALIPHATIC SOLVENTS

Aliphatic solvents are made exclusively from crude oils. Rigid specifications have been developed by close contact between industry and the consumer over a period of many years. Consistent and uniform quality is achieved by the care and attention taken in all phases of production, storage and shipment.

The odour associated with solvents fractionated from crude petroleum depends on the type of crude used. Special process for manufacturing aliphatic solvents with controlled odour levels, "mild odour solvents" were only available from selected crude sources. Now users of petroleum solvents are assured of "controlled odour quality" when using aliphatic solvents because the process developed by scientists eliminates the hydrocarbon compounds which cause undesirable initial and residual odour characteristics in this class of hydrocarbon solvents. The unique process used for the manufacture of high quality solvents also reduces the sulphur content of the product to one part per million, or 1/10,000 of 1%. Therefore, products meet all known sulphur corrosion tests required under the Federal Law.

Evaporation rates are an important and carefully controlled characteristics of these solvents. Excessive "light end" or "heavy tail" fractions lead to unpredictable initial and final boiling points with an even distribution of intermediate boiling components throughout the range. This enables the customer to choose the exact solvent best suited for his purpose, with the assurance that whether the evaporation rate is fast or slow, it will be uniform.

There are three lines of aliphatic solvents - "Conventional", "Deodorized" or "Low Odour" and "Odourless".

"Conventional" solvents are produced from crude oils by distillation and treating. The latter results in greatly improved odour characteristics when compared with products made from selected crudes.

"Deodorized" or "Low Odour" solvents undergo the same processing as "Conventional" solvents, followed by an additional chemical treating step which results in a very mild odour product.

"Odourless" solvents are the outcome of extensive research by scientists who have developed a unique new process to produce a negligible odour level. These products are iso-paraffinic in chemical structure.

AROMATIC SOLVENTS

A demand exists for partial aromatics which can be satisfied economically by purchasing aromatic content solvent and blending back to the required solvency value with Imperial Aliphatic solvents.

TOLUENE AND XYLENE are narrow cut solvents whose quality is well within the limit governing nitration grade materials. End uses are mainly in the surface coating field in the production of industrial finishes.

For further information consult your manufacturer or the supplier.

FORMULAS FOR MIXING & DETERMINING PERCENTAGES OF PESTICIDES1. Formula for Diluting, Emulsion, Solutions, Dusts, or Dry Baits:

The following formula should be used when preparing pesticides formulations by percentage & volume or by parts:

Equation # 1:

$$\frac{A \times B}{C} = D$$

where:

A	=	amount desired
B	=	% desired
C	=	% concentrate of stock
D	=	amount of concentrate stock to be used

Example:

if 10 gallons of 2% chlordane is desired, and the standard stock 20% of chlordane is to be diluted with No. 2 fuel oil then:

$$\frac{10 \times 2}{20} = \frac{20}{20} = 1 \text{ gallon of 20\% chlordane}$$

∴ 10 gallons desired
 - 1 gallon of concentrate to be used
 9 gallons of #2 fuel oil to be added.

2. Diluting Wettable Powders

Same formula applies as in Equation No. 1 except 10 is added (8.34 US gal) for weight of gallon of water.

Example:

10 gallons of 2% chlordane are desired, and 50% W.P. is to be diluted with water, then:

$$\frac{10 \times 10 \times 2}{2} = \frac{200}{50} = 4 \text{ pounds}$$

∴ 4 pounds of 50% W.P. of chlordane to be added to 10 gallons of water. The increase in volume due to the addition of the powder can ordinarily be neglected.

3. Finding % of Finished Emulsions, Solutions, Dusts, or Dry Baits

Apply the same formula as in equation no. 1.

Example:

If 1 gallon of 20% chlordane is mixed with 9 gallons of water, what is the percentage of chlordane in the finished product?

$$\frac{1 \times 20}{(1 + 9)} = \frac{20}{10} = 2\%$$

where:

1 = 1 gallon of chlordane
9 = 9 gallon of water

4. Finding Percentage of Finished Suspension & (W.P.)Equation No. 2

$$\frac{A \times B}{C \times D} = E$$

where:

A = amount of concentrate used
B = strength of concentrate
C = gallon of finished stock
D = 10, to be used for imp. gallon or
8.34 for American
E = % finished stock.

Example:

If 7 pounds of 50% chlordane W.P. are mixed with 25 gallons of water, what is the % of chlordane in the finished suspension?

$$\frac{7 \times 50}{25 \times 10} = \frac{350}{250} = 1.4\%$$

SOME EXAMPLES

1. To determine the % of active ingredient in a spray mixture.

Formula:
$$\frac{(\text{lbs of insecticide used}) \times (\% \text{ of active ingredient})}{\text{gals. of spray mixture} \times 10}$$

Use: 10 for Imp. gal.
8.34 for U.S. gal.

Example:

8 pounds of 40% chlordane wettable powder were mixed in 100 gal. of water. What percentage of chlordane did the finished product contain?

$$\frac{8 \times 40}{100 \times 10} = \frac{320}{1000} = \frac{32}{100} = 0.32\%$$

or

$$\frac{8 \times 50}{100 \times 8.31} = \frac{400}{830} = 0.48\%$$

2. To determine the pounds of wettable powder needed to mix a spray containing a given percentage of active ingredient.

Formula:
$$\frac{\text{gals. of spray wanted} \times \% \text{ active ingred. wanted} \times 10}{\% \text{ active ingredient in insecticide used}}$$

Example:

How many pounds of lindane 25 W.P. are needed to make 100 gal. of spray of 0.03% lindane?

$$\frac{100 \times 0.03 \times 8.3}{25} = 1.0 \text{ lb (U.S. gal.)}$$

$$\frac{100 \times 0.03 \times 10}{25} = 1.2 \text{ lbs (Imp. gal.)}$$

3. To determine the gallons of E.C. needed to mix a spray containing a given % of active ingredient.

Formula:
$$\frac{\text{gals. of spray wanted} \times \% \text{ active ingred. wanted} \times 10}{\text{lbs. active ingredient per gal. of concentrate} \times 100}$$

Example:

How many gallons of hetoxychlor of 25 E.C. (2 lbs/gal) are needed to make 100 gals of spray containing 0.25% methoxychlor?

$$\frac{100 \times 0.25 \times 10}{2 \times 100} = \frac{2.5}{2} = 1.25 \text{ gals. (Imp.)}$$

or

$$\frac{100 \times 0.25 \times 8.3}{2 \times 100} = 1.04 \text{ U.S. gals.}$$

EMULSIFIABLE CONCENTRATE % RATINGS IN POUNDS ACTUAL/GALLON

<u>% E.C.</u>	<u>Lbs/gal (U.S.)</u>
10 - 12	1.0
15 - 20	1.5
25	2.0
40 - 50	4.0
60 - 65	6.0
70 - 75	8.0
80 - 100	10.0

APPENDIX "B"

DILUTION AND CONVERSION TABLE

These are approximate proportions for mixing sprays for farm and home use and are not intended for formulating insecticides for resale. To obtain the following percentages of chemical in the spray mixture, use the amount of formulation indicated in 100 gallons of water. Figures in () indicate the amount to use in one gallon (U.S. gal).

Formulation	Amount of formulation to use when desired percent of chemicals in mixture is--						
	.03125%	.0625%	0.125%	0.25%	0.5%	1.0%	2.0%
10%-12% E.C. containing 1 lb. chemical per gal.	2 pt (2 tsp)	4 pt (4 tsp)	1 gal (8 tsp)	2 gal (16 tsp)	4 gal (10 tbs)	8 gal (2 2/3 pt)	16 gal (1 1/3 pt)
15%-20% E.C. containing 1 1/2 lb. chemical per gal	1 1/2 pt (1 1/2 tsp)	3 pt (3 tsp)	6 pt (6 tsp)	1 1/2 gal (12 tsp)	3 gal (7 1/2 tbs)	6 gal (1 1/2 pt)	12 gal (1 pt)
25% E.C. containing 2 lb. chemical per gal	1 pt (1 tsp)	2 pt (2 tsp)	4 pt (4 tsp)	1 gal (8 tsp)	2 gal (5 tbs)	4 gal (10 tbs)	8 gal (2 2/3 pt)
33%-35% E.C. containing 3 lb. chemical per gal	3/4 pt (3/4 tsp)	1 1/2 pt (1 1/2 tsp)	3 pt (3 tsp)	6 pt (6 tsp)	1 1/2 gal (4 tbs)	3 gal (8 tbs)	6 gal (1 1/2 pt)
40%-50% E.C. containing 4 lb. chemical per gal	1/2 pt (1/2 tsp)	1 pt (1 tsp)	2 pt (2 tsp)	4 pt (4 tsp)	1 gal (8 tsp)	2 gal (5 tbs)	4 gal (10 tbs)
57% E.C. containing 5 lb. chemical per gal	7/16 pt (7/16 tsp)	7/8 pt (7/8 tsp)	1 3/4 pt (1 3/4 tsp)	3 1/2 pt (3 1/2 tsp)	7 pt (7 tsp)	1 3/4 gal (4 1/2 tbs)	3 1/2 gal (9 tbs)
60%-65% E.C. containing 6 lb. chemical per gal	3/8 pt (3/8 tsp)	3/4 pt (3/4 tsp)	1 1/2 pt (1 1/2 tbs)	3 pt (1 tbs)	6 pt (2 tbs)	1 1/2 gal (4 tbs)	3 gal (8 tbs)
70%-75% E.C. containing 8 lb. chemical per gal	1/4 pt (1/4 tsp)	1/2 pt (1/2 tsp)	1 pt (1 tsp)	2 pt (2 tsp)	4 pt (4 tsp)	1 gal (8 tsp)	2 gal (5 tbs)
15% wettable powder	1 2/3 lb (2 1/2 tsp)	3 1/3 lb (5 tsp)	6 2/3 lb (10 tsp)	13 1/3 lb (7 tbs)	26 2/3 lb (1 cup)	53 1/3 lb (2 cups)	106 2/3 lb (4 cups)
25% wettable powder	1 lb (1 1/2 tsp)	2 lb (3 tsp)	4 lb (6 tsp)	8 lb (12 tsp)	16 lb (8 tbs)	32 lb (1 cup)	64 lb (2 cups)
40% wettable powder	5/8 lb (1 tsp)	1 1/4 lb (2 tsp)	2 1/2 lb (4 tsp)	5 lb (8 tsp)	10 lb (5 tbs)	20 lb (10 tbs)	40 lb (1 1/4 cups)
50% wettable powder	1/2 lb (3/4 tsp)	1 lb (1 1/2 tsp)	2 lb (3 tsp)	4 lb (6 tsp)	8 lb (4 tbs)	16 lb (8 tbs)	32 lb (1 cup)
75% wettable powder	1/3 lb (1/2 tsp)	2/3 lb (1 tsp)	1 1/3 lb (2 tsp)	2 2/3 lb (4 tsp)	5 1/3 lb (8 tsp)	10 2/3 lb (5 tbs)	21 1/3 lb (10 tbs)

APPENDIX "C"

PROPERTIES OF SOME COMMON SOLVENTS

Name	Common Uses	M.A.C. ppm	Auto Ignit. Temp. °F	Flash Point °F	Flammability Limits % volume/air	Fire Hazard	Toxic Hazard	Type of Injury
KEROSENE	Industrial Solvents, i.e. Pesticides Formulations	100	490	100-165	1.4-1.5	High	Low	Intoxication, narcosis, central nervous depressant
MINERAL SPIRIT (Varsol)	Industrial Solvents, i.e. Pesticides Formulations	100	450	86-105	1.4-5.5	High	Low	
NAPHTHA (Stoddard, Safety solvent)	Industrial Solvents, i.e. Pesticides Formulations	100	500	100-110		High	Low	Almost no effects
TOLUENE		100	1026	40	1.0-7.0	High	Low	As benzol, but less pronounced, narcosis nervous disorders and liver damage.
XYLENE		100	924	81-90	1.0-7.0	High	Low	Similar to Toluene

Information: M.A.C. - as adopted by ACGIH for 1972.
Other information obtained from manufacturers' manual.

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